

NASA-CR-192453

FINAL TECHNICAL REPORT  
NASA CONTRACT NAS8-37582

Entitled

DEVELOPMENT OF A MINIATURE MASS ANALYZER AND  
ASSOCIATED INSTRUMENTATION FOR IMPROVED CAPABILITIES IN THE ANALYSIS  
OF LOW ENERGY PLASMAS FROM A ROCKET OR SATELLITE PLATFORM

Submitted To

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
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PRINCIPAL INVESTIGATOR: Dr. John H. Hoffman

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## INTRODUCTION

The University of Texas at Dallas (UTD) Center for Space Sciences (CSS) under the direction of Principal Investigator Dr. John H. Hoffman has designed, developed, and fabricated three (3) each "Miniature Mass Spectrometers and Associated Instrumentation in fulfillment of the requirements of NASA Contract NAS8-37582 and in support of the research activities of the NASA MSFC Space Sciences Laboratory and the rocket program of Dr. Thomas E. Moore. The ion mass spectrometer analyzers furnished under this contract were modeled after the unit developed under NASA Grant NAG8-005 with modification as necessary to meet changing mission requirements.

### Magnetic Sector Description

The mass analyzers consist of a 90° magnetic sector similar to the De-RIMS instrument. The incoming ions are focussed into two simultaneous channels using two discrete continuous dynode electron multipliers as detectors. The two mass channels have the ratio of 1:4. Mass 4 amu and mass 16 amu or mass 1 amu and mass 4 amu are read out simultaneously. The unit covers the mass range of mass 1 amu to mass 64 amu. The magnetic sector uses Neodymium Iron Boron (NdFeB) 32H magnet material to obtain a gap field strength of 3400 gauss.

The magnetic sector analyzer components are mounted upon a single base plate which functions at the mass selection voltage potential. The inlet drift tube, sector magnet, high mass drift tube and detector, and low mass detector are aligned for mass focusing by their positioning on the sub-base plate. The sub-base plate is then mounted on insulating stand-offs into the instrument baseplate chassis. The detector pulse counting amplifier is mounted below the base plate on the underside of the analyzer chassis so that the connection to the channeltron detector is kept very short, minimizing noise pickup at this sensitive point. The analyzer chassis unit provides a mounting surface to receive the ion inlet assembly built by MSFC/SSL. This combined assembly is installed into an instrument chassis provided by MSFC/SSL. The analyzer subassembly weighs 1603 g.

### Ion Detector Description

The mass focussed ions are collected by 4800 series CEM's which produce a pulse of charge for each ion received. The charge pulse is next feed to a charge pulse amplifier containing an Amptek Model 101. A fixed width voltage pulse is delivered by the pulse amplifier output to a serial binary counter which is a part of the STICS control electronics.

### Amplifier and Power Supply Descriptions

The electronics which interface with the mass analyzer ion focussing elements have been adapted from circuit designs used on previous successful flight programs. The circuits furnished under this contract are listed below:

- (a) Mass selection high voltage power supply -3 required. Printed Circuit Board Assembly P/N UTD 157-025 (MSFC 42A31362); voltage range: 0V to -2500 Vdc; D/A: 12 bits; Power: 400 mw; Weight: 223 g
- (b) Channeltron detector high voltage power supply -3 required. Printed Circuit Board Assembly P/N UTD 157-020 (MAFC 42A31363); Voltage range: 0 to -3000Vdc; D/A: 12 bits; Power: 380 mw; Weight: 219 g

- (c) Angle selection power supply -3 required. Printed Circuit Board Assembly P/N UTD 157-015 (MSFC 42A3161); Voltage range: 0 to  $\pm 300$  Vdc; D/A: 12 bits; Power: 100 mw; Weight: 123 g
- (d) Energy selection and medium voltage power supply -3 required. Printed Circuit Board Assembly P/N UTD 157-010 (MSFC 42A3160); Voltage range: energy 0 to +200, medium  $\pm 320$  Vdc; D/A: 12 bits; power: 169 mw; Weight: 170 g
- (e) Detector Charge Pulse Amplifier -6 required. Printed Circuit Board Assembly P/N UTD 157-030. Weight: 24g; Power: 25 mw; Gain: 23 db; Pulse Pair Resolution: 620 nsec at .2 pc
- (f) TECHS high voltage power supply - 2 required. Printed Circuit Board Assembly PN UTD 157-035; Voltage Range: 0 to + 3000 Vdc; D/A: 12 bits; Power: 500 mw; Weight: 219 g.

### Test Results

The mass analyzer is checked for mass alignment using laboratory electronics. The components are positioned on the base plate so that the mass 4 of the low mass channel and mass 16 of the high mass channel are correctly aligned. The Channeltrons are positioned for best peak shape. An analog record of the two channel spectra is recorded by using a strip chart, logarithmic amplifier and RC discharge voltage sweep. After the alignments are complete an end-to end test is performed to verify the operation of the pulse amplifiers.

The electronics cards are tested over temperature ( $-20^{\circ}$  C to  $+ 50^{\circ}$  C) before and after conformal coat. A sample of the analog spectra for the SN 3 mass analyze is shown by Figure 1.

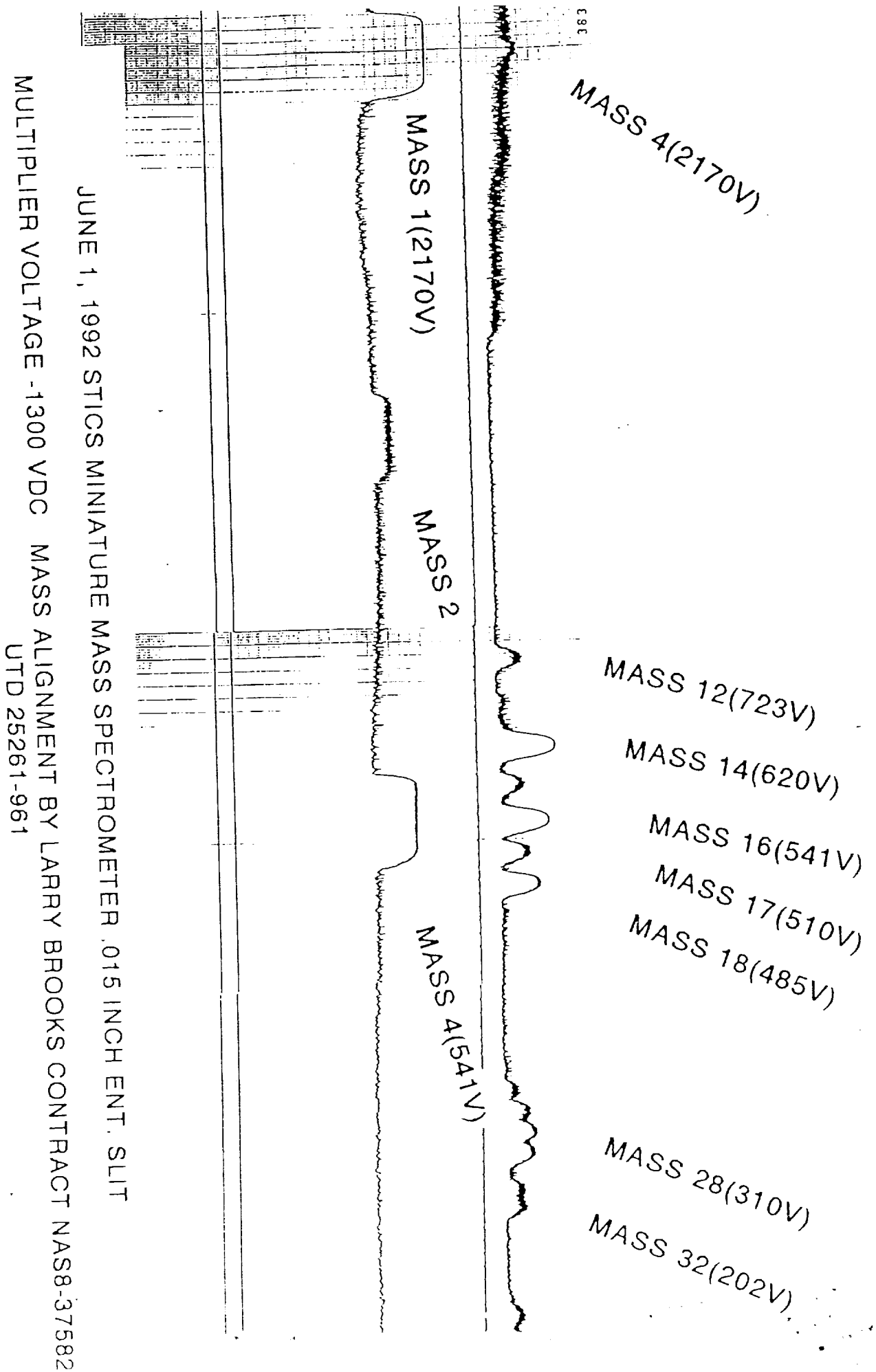


Figure 1. Mass Spectra for Serial No. 3 Mass Analyzer